Laser Ablator for Decontamination of Metal Surfaces

The Challenge

Hanford has large volumes of stored contaminated remote handled mixed low-level (MLLW) and transuranic (TRU) waste. Significant quantities of both contact handled and remote handled waste will be generated during cleanup activities over the next 35 years. The current and future waste management cost could be significantly reduced if an economical surface decontamination method can be found to reduce the volume of the remote handled waste or reduce the volume of TRU waste by reclassifying to low-level waste. The majority of contamination on waste items including tools, equipment and materials is on the surface.

Above – technician (wearing eye protection) for inspecting a Hanford "T" handle sample carrier. Left – bayonet sample carrier cap undergoing laser surface decontamination.

Current Approach

Current approaches, which include the use of chemical solvents, water jet cleaning and pellet blasting, produce significant amounts of secondary waste and/or are only effective on smooth surfaces with loose contamination.

New Technology

Laser ablation is a technology that has high potential for cleaning a variety of surfaces with loose or fixed contamination without generating significant amounts of secondary waste. Key performance requirements include ability of the system to remove fixed contamination from a variety of surfaces and shapes while controlling contamination spread and meeting applicable emissions standards (ALL of the material removed from the surface must be collected). The system must also meet the Hanford Site laser operation safety standards for eye and skin protection.

Benefits and Features

- Cleans surfaces without generating significant amount of secondary waste
- Can be controlled to pinpoint accuracy
- Can adjust for various surface types

At least one potential vendor has shown that it can meet these requirements in a demonstration using a low energy pulsed Neodymium Yttrium Aluminum Garnet (Nd:YAG) laser, a safe and reliable technology for cleaning metal surfaces. The demonstration was conducted with a 200-watt laser, operating at approximately 120 watts and about 10,000Hz. The beam was focussed on approximately 1 micron of surface area on the specimen using a fiber optics delivery system.

Demonstration Description

Three different high-level waste sample carriers were coated with contamination simulant and sent to General Lasertronics Corporation for the demonstration. The sample carriers were not radioactively contaminated and were selected to represent various shapes and sizes as may be encountered in lab operations. A video camera was used to document the demonstration.

To simulate contamination, the sample carriers were coated inside and out with a paint visible only with UV light. Green paint was also applied to some of the surfaces for visual effect under ordinary light to aid the video recording. The effectiveness of the system was qualitatively monitored by observing the removal of green paint and UV visible paint. No attempt was made to quantitatively measure the actual surface depth removed.

Demonstration Results

The demonstration results in terms of three areas of interest were as follows:

Effectiveness - The laser ablator had no difficulty cleaning surfaces of the lead and stainless steel sample carriers that can be accessed even at a large incidence angle. Difficulty was, however, encountered in getting the laser to contact the vertical surfaces of small diameter boreholes. While not demonstrated, it appeared a laser system could be designed to clean the tight spaces such as bored holes and inside corners.

Only slight adjustments in the laser focussing system were necessary to accommodate changes in material properties of lead and stainless steel. The low energy density employed cleaned lead somewhat faster than shiny stainless steel surfaces. This might be expected if energy absorption/reflection at the surface and melting or vaporization temperature are key factors in disengaging the contaminant from the surface.

Safe Operation is Feasible - Safe and controlled operation appeared feasible. Laser safety glasses will be required as expected. Skin protection was not required during the demonstration as shown more explicitly in the video. The system could be controlled and lends itself to automation with pin-point accuracy.

Collection of Ablated Material - Does the technology just smear the surface or spread materials around? Does it vaporize the material in such a form that it cannot be collected in HEPA filters? Answers to these questions will require more work than was covered in this demonstration.

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